

# Innovative Teaching Tools for Large Multicultural Cohorts in Electrical Engineering and Electronics

Ali Al-Ataby\*, *Member, IEEE*

**Abstract**—Teaching a multicultural cohort is often a challenging task. This task becomes more challenging if the size of the cohort is large. Students in such cohorts often feel they are not having a personalised experience, isolated from the lectures and are usually dealt with as numbers. This results in a lack of enthusiasm and engagement as far as the students are concerned, and may jeopardise the teaching and learning process. Moreover, the lack of resources and staff shortages (high student-to-staff ratio) make the situation even worse. In such cases, the use of technology may provide solutions to the aforementioned problems in order to deliver a rich, personalised and engaging learning experience to the students. This paper presents a number of innovative teaching tools to enhance student experience. Student feedback has shown that the students are using these tools extensively, and their overall satisfaction is high.

Technology-enhanced Learning, large cohort, multicultural, student experience.

## I. INTRODUCTION

Teaching large cohorts is one of the most difficult academic tasks in the Universities today. A large cohort generally includes 100+ students, but there is no standard number for this. In some cases, a large cohort may be a one with 50-80 students, and in others, it may include up to 1500 students in a single cohort. Large cohort are mostly common in the first or second years of study at university. This often carries an additional responsibility of supporting students at early stages in their transition to university, while also introducing them to learning in the university context. Teaching large cohort requires a combination of skills and strategies, such as organising and presenting effective lectures, engaging students, crowd control and the utilisation of interactive learning elements [1]. As an addition to the above, if the cohort is multicultural, this will add more complexity to the teaching and learning process. Problems like communication barriers and cultural shock will be very evident in this case, which will lead to lack of enthusiasm and engagement and a feel of isolation. Universities nowadays are facing a real challenge of how to tackling the issues associated with teaching large and multicultural cohorts.

As a way to enhance student experience for large and multicultural cohorts, and to provide a sense of personalisation, the use of technology-based tools could be a way to tackle the associated problems [2]. Information and communication

technologies (ICT) is now an integral part of the daily lives of many people. It is highly integrated into the whole higher education experience as well. The students of the current era are digitally literate, like mobility, like to stay connected (always on-line) and they can multitask efficiently while they are in the class [3]. In 2009, the National Union of Students (NUS) called for universities and lecturers to review their teaching methods to assess whether they are sufficiently taking advantage of new technologies. In order to collect student perspectives on technology, the Higher Education Funding Council for England (HEFCE) commissioned the NUS to undertake research into the demand, perceptions and training needs of students in both further and higher education [4]. This research showed that the students believe that ICT (or the use of technology in general) improves their learning experience, and they want the academics to use more ICT tools, besides the fact that they feel their lecturers need additional training in technologies. Also, this research showed that students requested more use of the latest technology, and for this to be part of the overall learning experience. They also asked for an integration between the virtual learning environments (VLEs), lectures and the entire learning experience [4].

Every university nowadays encourage the use of the VLE in the form of an electronic blackboard system (or any equivalent systems), with the majority of lecture notes and material are now made available to students electronically [5], [6]. This can be used for other purposes like on-line exercises and homework to be completed and submitted by the students and assessed electronically for them. Also, along with the electronic blackboard system, an electronic submission system is used for on-line submission of coursework elements and laboratory reports, where plagiarism and collusion checks can be made. The use of the electronic blackboard system is obviously of a huge advantage to the students, yet, more can be done to enhance student experience beyond just a repository to store documents (PPTs and PDFs) or submit a coursework [7].

This paper presents a number of innovative teaching tools to enhance student experience and engagement in large multicultural cohorts. Student feedback has shown that the students are using these tools extensively, and their overall satisfaction is high with the modules where these tools are used.

## II. THE CASE STUDY

As a case study, a second year module will be referred to in this paper. The module is a 15-credit, with no practical work (laboratory). It is basically a combined module of two

\* Ali Al-Ataby is with the Department of Electrical Engineering and Electronics, University of Liverpool, email: [ali.al-ataby@liverpool.ac.uk](mailto:ali.al-ataby@liverpool.ac.uk). He is the winner of The Sir Alastair Pilkington Award for Teaching Excellence, and the Faculty of Science and Engineering Learning and Teaching Award.

7.5-credit modules, delivered in one semester (12 weeks) by one lecturer. The students that are taking this module are progressing students (a majority of home and EU students and some international students) and direct intake from a sister university in China. The overall number of students in this module is usually 300+. This module is a very important and core module for students studying Electrical Engineering and Electronics programme (EEE), and it is pre-requisite for other third year modules. It requires a very good knowledge in electrical circuit analysis and mathematics (both are the pre-requisites for this module).

This module was known to be difficult, not very popular (although it is a core module), with some issues like low average, high failure rate and low satisfaction rate. Moreover, student engagement and interest were very worrying. Also, the students felt very isolated from the lecturer (because of the large class).

As a way to rectify the associated issues, and enhance student experience with that module, a three-year plan for remodelling the delivery of the module through the utilisation of innovative teaching methods was put. A wide variety of tools and utilities have been tested and used to engage the large cohort. Many of these tools were self-developed, and others were just used off-the-shelf. These tools were applied for the first time within the EEE Department and the School of Electrical Engineering and Computer Science.

The next section provides a brief description of some of the tools that were used.

### III. THE USED TOOLS

The main idea of using the interactive tools was to engage the students in- and off-lectures through the blackboard system (called Virtual Interactive Teaching At Liverpool or VITAL). All the tools, utilities and systems were required to be used within (or integrated with) VITAL because it is not a good idea to confuse the students with different systems, portal, web pages, links...etc. In other words, the blackboard system is required to act as a single point of access to all the tools and utilities for student convenience. This is a very important recommendation when trying to introduce any new service to the students. Figure 1 shows a screenshot of the blackboard™ system VITAL, and Figure 2 shows the tool list in Learning Resources page.

The following sub-sections briefly illustrate some of the used tools:

#### A. The Virtual Lab

To let the students test the theoretical aspects of the aforementioned module practically, a virtual lab tool (using GeoGebra™ free software - Java based) was created. A number of experiments were designed and developed, and made available through VITAL (run within the page). The experiments provide real-time animations and they are more advanced than simulations because some measurements can be taken and different component values can be tested. The experiments can be run from anywhere and at anytime (24/7 access). It is worth mentioning that the tool is cross-platform

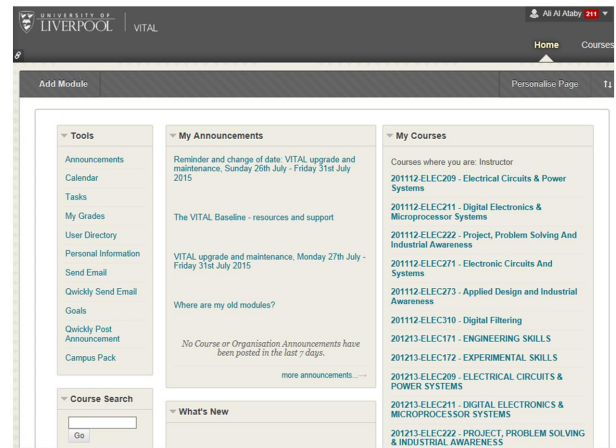


Fig. 1. The Blackboard System VITAL

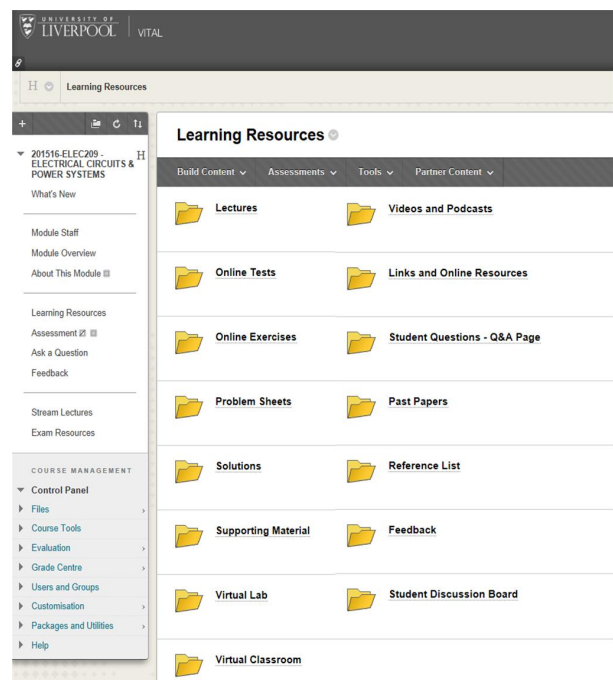


Fig. 2. Tools Accessibility from Learning Resources page

(Windows™, Mac OS™...etc). Figure 3 and 4 show two examples of experiments.

#### B. Mobile Applications

Smart phones/tablets are an integral part of today's life. During a lecture, if the students lose interest or focus, they tend to use these gadgets for gaming, texting or posting on social media. Accordingly, there should be a way to utilise these devices for teaching and learning purposes. Educational mobile applications can be developed and customised for a module, and all lecture examples and problem classes can be tested and their answers can be verified using these applications. This will engage the students more in- and off-lecture and helps in the process of learning. If the development of a mobile application for a module is time-consuming and costs efforts and money, then a useful mobile application may be

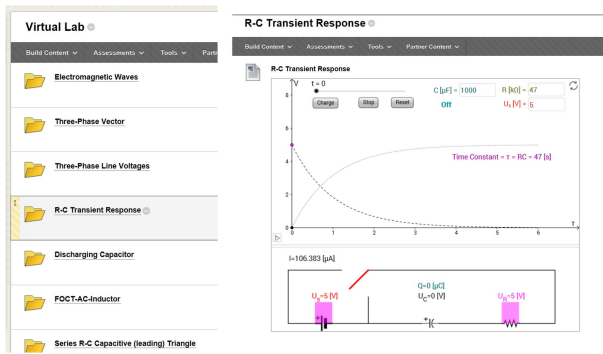


Fig. 3. Virtual Lab Tool - Transient Circuit

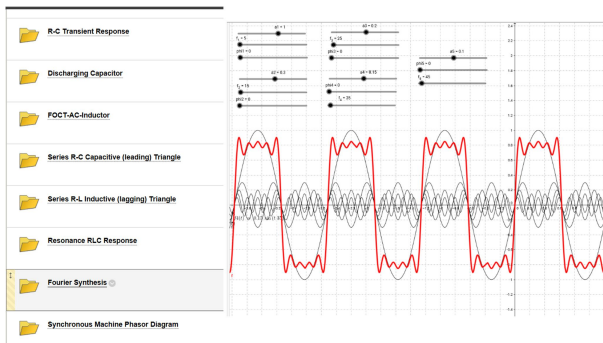


Fig. 4. Virtual Lab Tool - Fourier Synthesis

found in the stores due to the availability of huge number of applications in the Electrical/Electronic engineering discipline. A mobile application supporting the aforementioned module learning was recommended for the students (called Circuit Jam™), shown in Figure 5.



Fig. 5. Circuit Jam™ Mobile Application

### C. On-line Course for Bridging the Gap in Pre-requisites

It is always a good idea to check if module pre-requisites knowledge is available with the students before starting a module. The students are advised to take a formative on-line test through VITAL during the first week of the semester, and based on the result of that test, they will be advised whether there is a problem in the pre-requisite or not. One of the solutions in case of a problem is to ask the student to take

an on-line course through the blackboard system. This course can be in the form of a MOOC (Electrify: An Introduction to Electrical and Electronic Engineering, University of Liverpool - FutureLearn) or a standard on-line course from one of the trusted providers. There are many free on-line courses in the area of Electrical Engineering and Electronics.

### D. On-line Tests and Exercises

The blackboard VITAL is equipped with an on-line test tool. This can be used for various purposes, such as pre-requisite checking, homework and exercises (Figure 6). Other on-line exercise tool (Java-based third party) can also be used and integrated inside VITAL. They can provide detailed worked examples and used as a revision and practice tool (Figure 7).

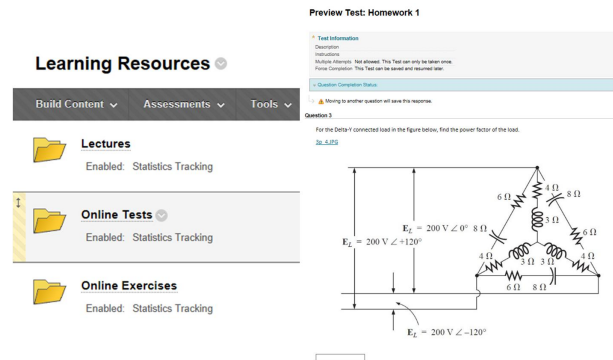


Fig. 6. On-line Test Tool

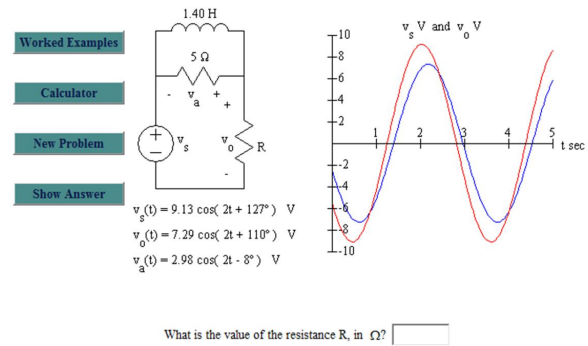


Fig. 7. On-line Exercise Tool

### E. On-line Question Tool

With a large and multicultural cohorts, students tend not to ask questions during lectures, usually because of being shy besides the language barrier. However, if they have important questions about the material of the module, they find it easy to send emails to the lecturer. On the other hand, other students have questions but they tend not to send email because they think their questions may be silly and this could damage their image in front of the lecturer. Moreover, many students may send very similar questions about the material, and replying



to such questions may take time from the lecturers. Some questions are very specific and in the core of the material, and it'd be better if the answer is conveyed to all the students in the cohort. For the above mentioned module, it was decided that no questions (about the material) to be sent by emails the lecturer. Instead, an on-line tool was built (using Google forms) to send questions by students to the lecturer. The tool is anonymous and integrated within VITAL. When a student send a question, a notification is received by email and text message to the lecturer, and who can approve and answer the question by email or test as well. The answer will appear in one place (called Q&A Page - Student Questions), visible to all the students in the blackboard. The questions can be archived from one year and used for the coming year. The result of this was less emails and questions (because many students may have common questions). Figure 8 shows a screenshot of the tool.

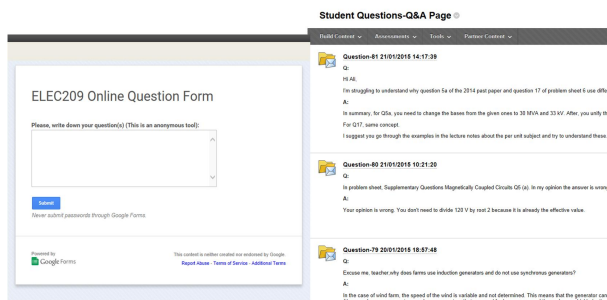


Fig. 8. The On-line Question Tool

### F. Real-time Texting and Voting

Textwall™ for real-time texting and Polleverywhere™ on-line voting system are highly recommended to engage students in a large cohort during lectures. Both tools can be used to respond to questions posted by the lecturer and participating in discussions. They also provide a real-time feedback during the lectures. Students use their mobile phones and tablets to participate in voting for a question or send feedback during lectures. Figure 9 shows a screenshot of both tools.

### G. Lecture Capture

Stream Capture is an in-house developed software by Computer Service Department and is used to video-record lectures for the students and make these available in VITAL. Almost all lecture theatres in the University have all the required hardware/software to record lectures. The software can be used not only to record lectures, but to record other sessions for purposes like briefing the students about practical work (before attending the labs), recording generic feedback sessions and tips and hints about the module. Students (especially, international) like the idea of finding a record of the lecture that can watch many times to understand it fully. All the recorded videos will be available in another system (called stream server), and can be embedded in other systems. Figure 10 shows a screenshot of the tool. Statistics (number of hits) have shown that the students are using this feature extensively, and this is not leading to a fall in student attendance.

A voltage of 10V is put across a resistance of 5Ω. What is the value of the current that will pass through this resistance?

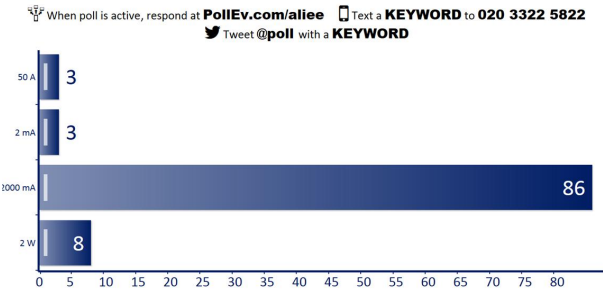


Fig. 9. Polleverywhere™ and Textwall™

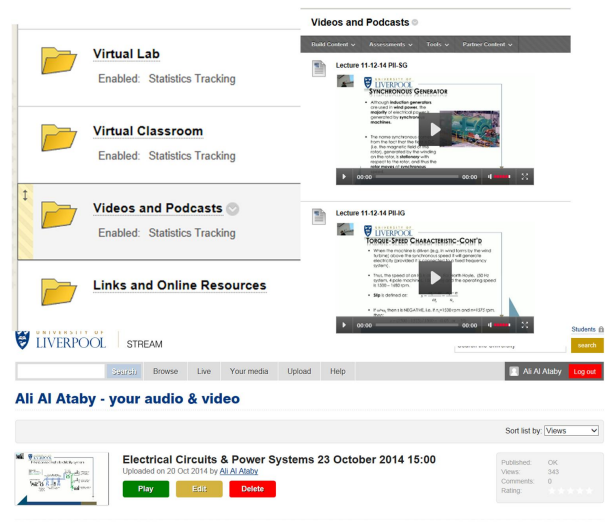


Fig. 10. Stream Capture System

### H. Virtual Classroom System

Adobe Connect™ system is an on-line virtual classroom environment that can be used to deliver live lectures. This tool was used to deliver extra sessions for problem classes and tutorials for the modules. The students are informed about the time when this session is to be delivered and they can access the session through the blackboard and can join it using a mobile device or a PC. The sessions can be recorded and made available through the blackboard later to the students. Figure 11 shows a screenshot of this tool.

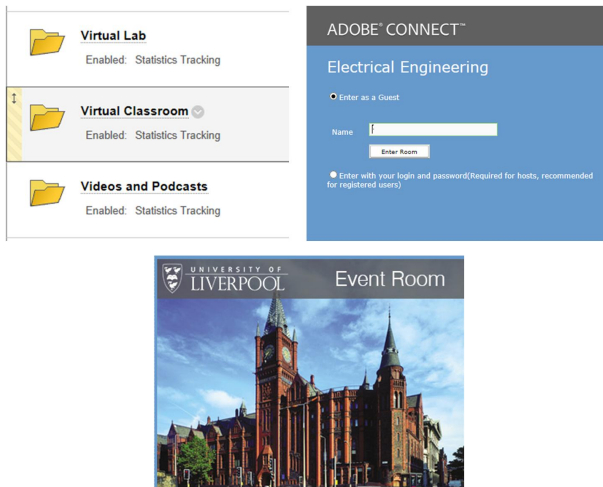


Fig. 11. Virtual Classroom With Adobe Connect™

### I. On-line Feedback Tool

The students were providing a continuous on-line feedback (anonymous) about the module and about all the tools to see which ones are suitable and which ones are not. Again, the feedback tool is made available within VITAL, and it is built using Google forms. It provides questions with rating scale and free text as well. An analysis report can be extracted easily from the tool. The feedback was monitored and responded to during the semester. It should be mentioned that this feedback was collected irrespective of the feedback collection process followed by the EEE Department. Figure 12 shows a screenshot of the tool.

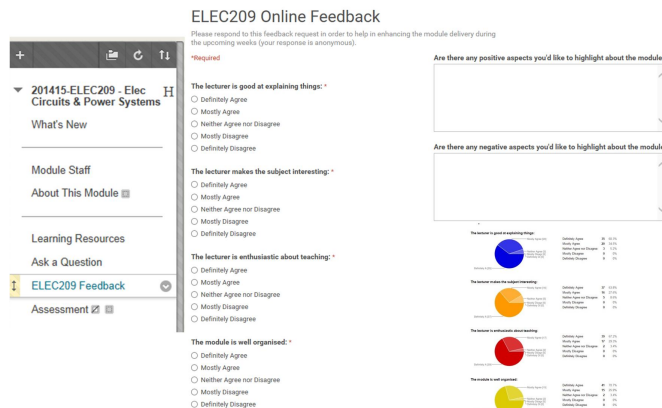


Fig. 12. The On-line Feedback Tool

## IV. PERFORMANCE RESULTS

The current situation of the module is that it is the top rated EEE module (for the third year), with 93% satisfaction (Figure 13). It is the only module in the second year to achieve satisfaction rate that is 90%+ according to student questionnaires. It has an average that is within the expected range and has a low failure rate. It becomes now one of the most popular modules in the second year. It has the highest student attendance rate (Table I), although all the lectures are

video-recorded, yet the majority of the students preferred to attend because it has been a very engaging module.

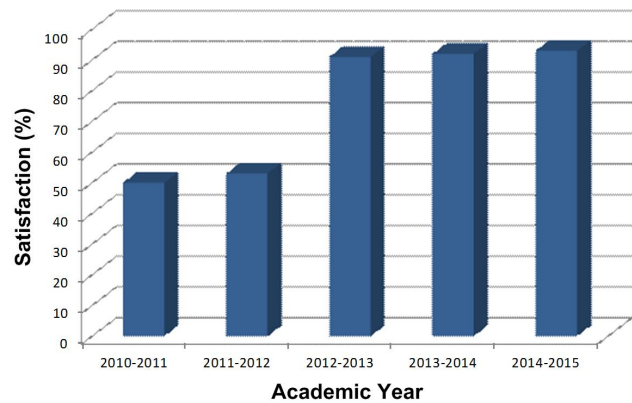


Fig. 13. Module Student Satisfaction Rate in the Last Five Years

TABLE I  
SECOND-YEAR ATTENDANCE RATES FOR THE CORE MODULES

Module	Attendance Rate (%)	Lecture Capture
ELEC202	67	No
ELEC271	67	No
ELEC212	74	No
ELEC270	76	No
ELEC207	77	Yes
ELEC211	78	Yes
ELEC210	81	No
<b>ELEC209</b>	<b>86</b>	<b>Yes</b>

The statistics of the on-line question tool is shown in Table II. It can be seen that the use of this tool has reduced dramatically the number of emails. It should be mentioned that the on-line question tool was used for the first time in the year 2013-14. Also, questions for 2013-14 were migrated to 2014-15 module and made available to students on VITAL.

TABLE II  
ON-LINE QUESTION TOOL STATISTICS

Year	No. of Emails	No. of On-line Questions
2012-13	93	0
2013-14	14	81
2014-15	6	48

## V. CONCLUSION

The students are using the tools mentioned in this paper extensively. This was verified by the statistics, feedback and surveys. They highly appreciate all these innovative teaching and learning tools/methods. The same tools can be used for other modules and purposes (third year modules, labs, ...etc). The tools have improved student experience and engagement in this large and multicultural cohort. This has contributed to

the Departments reputation and excellent performance in the NSS. It should be mentioned that other tools were tested but they didn't work well with the students. Also, tools that work well with one cohort may not work well with another.

#### ACKNOWLEDGMENT

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